

Applicant : Qian Chen et al.  
Serial No.: 09/848,773  
Filed : May 3, 2001

Attorney's Docket No.: 06666-076001

Amendment to the Claims:

This listing of claims replaces all prior versions, and listings, of claims in the application:

1-12. (Canceled)

13. (Currently Amended) A method as in claim 75 ~~A method,~~  
~~comprising:~~

~~obtaining two images of similar image information from two~~  
~~uncalibrated sources;~~

~~superimposing lines formed on said images to rectify the~~  
~~two images relative to one another to form rectified images;~~

~~using said rectified images to form three dimensional~~  
~~information by forming a disparity map of three dimensional~~  
~~information for specified coordinates of matching pixels;~~

~~wherein said using comprises forming a three dimensional~~  
~~surface indicative of three dimensional information contained in~~  
~~said two images, and forming a variable which indicates a~~  
~~likelihood of error in said three dimensional surface, and~~

~~wherein said forming a variable comprises forming a~~  
~~plurality of seed voxels which have a probability of being~~  
~~correct greater than a specified amount which makes it unlikely~~

Applicant : Qian Chen et al.  
Serial No.: 09/848,773  
Filed : May 3, 2001

Attorney's Docket No.: 06666-076001

~~that the voxels will not be correct,~~ and tracing a surface of  
~~from said plurality of seed voxels.~~

14. (Currently Amended) A method as in claim 13, A method,  
~~comprising:~~

~~obtaining two images of similar image information from two~~  
~~uncalibrated sources;~~

~~superimposing lines formed on said images to rectify the~~  
~~two images relative to one another to form rectified images;~~

~~using said rectified images to form three dimensional~~  
~~information by forming a disparity map of three dimensional~~  
~~information for specified coordinates of matching pixels;~~

~~wherein said using comprises forming a three dimensional~~  
~~surface indicative of three dimensional information contained in~~  
~~said two images, and forming a variable which indicates a~~  
~~likelihood of error in said three dimensional surface;~~

~~wherein said forming a variable comprises forming a~~  
~~plurality of seed voxels, and tracing a surface of said~~  
~~plurality of seed voxels; and~~

wherein said tracing is carried out for a plurality of said  
voxels in a multiresolution fashion, such that certain voxels  
are computed at a coarsest level, and other voxels are computed  
at a more detailed level.



Applicant : Qian Chen et al.  
Serial No.: 09/848,773  
Filed : May 3, 2001

Attorney's Docket No.: 06666-076001

15. (Original) A method as in claim 13, wherein said tracing comprises calculating an entire volume at the coarsest level, and calculating some amount less than the entire volume at a subsequent level.

16. (Original) A method as in claim 13, further comprising selecting a seed voxel by finding uniqueness.

17. (Original) A method as in claim 13, further comprising selecting the seed voxel using a winner take all technique which has a maximum correlation value.

18. (Original) A method as in claim 17, further comprising identifying seed voxels which represent incorrect matches, and removing said seeds after said tracing.

19. (Currently Amended) A method as in claim ~~13~~ 75, wherein said using comprises converting said volume to a plurality of Euclidean points.

20. (Original) A method as in claim 19, wherein said converting comprises projecting a reconstruction of said volume,

Applicant : Qian Chen et al.  
Serial No.: 09/848,773  
Filed : May 3, 2001

Attorney's Docket No.: 06666-076001

and then reconstructing Euclidean points from said projective reconstruction.

21. (Original) A method as in claim 19, wherein said converting comprises transforming an origin of a coordinate system to an origin of one of said images.

22. (Original) A method as in claim 20, wherein said reconstructing comprises allowing a user to input a parameter, and adjust the parameter to approximate a proper Euclidean reconstruction.

23. (Original) A method as in claim 22 wherein said parameter is focal length.

24. (Original) A method as in claim 13, further comprising dividing said surface into a plurality of parts, and said seed voxels are respectively for said plurality of parts.

25-28. (Canceled)

29. (Previously Presented) A method comprising:  
obtaining first and second images of the same object;

Applicant : Qian Chen et al.  
Serial No.: 09/848,773  
Filed : May 3, 2001

Attorney's Docket No.: 06666-076001

identifying objects in said first and second images, and  
forming lines which intersect said objects;  
aligning said lines in an epipolar geometry representation;  
using said first and second images, with said aligned  
lines, to form three-dimensional information;  
identifying at least one seed voxel, with a relatively high  
probability of being a correct three-dimensional measure; and  
forming at least a part of said surface map by propagating  
from said seed voxel.

30. (Canceled)

31. (Previously Presented) A method as in claim 29,  
wherein said identifying at least one seed voxel comprises  
selecting a seed voxel that has three-dimensional information  
for corresponding pixel information  $u, v$  that is unique and has a  
probability of being correct which is greater than a specified  
threshold.

32. (Previously Presented) A method as in claim 29,  
further comprising identifying a plurality of seed voxels for  
each of a plurality of different parts of the three-dimensional  
surface information.

Applicant : Qian Chen et al.  
Serial No.: 09/848,773  
Filed : May 3, 2001

Attorney's Docket No.: 06666-076001

33. (Original) A method as in claim 31, wherein said specified threshold is greater than 0.99.

34. (Previously Presented) A method as in claim 32, further comprising determining intersections between voxels at said different parts, and determining which of two voxels to use at said intersections.

35. (Previously Presented) A method as in claim 34, wherein said determining which voxels to use comprises determining a probability of each of the two voxels, and selecting the higher probability as the voxel to use.

36. (Previously Presented) A method as in claim 32, wherein said propagating comprises finding neighbors for voxels, one by one.

37. (Previously Presented) A method as in claim 29, wherein said identifying at least one seed voxel comprises selecting a seed voxel that has three-dimensional information for corresponding pixel information that best matches the

Applicant : Qian Chen et al.  
Serial No.: 09/848,773  
Filed : May 3, 2001

Attorney's Docket No.: 06666-076001

corresponding pixel information, and has a probability of being correct which is greater than a specified threshold.

38. (Original) A method as in claim 37, further comprising identifying voxels which represent incorrect matches, and removing said voxels which represent incorrect matches.

39. (Previously Presented) A method comprising:  
obtaining first and second images of the same object;  
identifying objects in said first and second images, and forming lines which intersect said objects; and  
aligning said lines in an epipolar geometry representation further comprising using said first and second images, with said aligned lines, to form three-dimensional information;  
wherein said three-dimensional information includes a disparity map, and further comprising converting said disparity map into three-dimensional Euclidean points; and  
wherein said using is carried out for a plurality of said images in a multiresolution fashion, such that certain image information is computed at a coarsest level, and other image information is computed at a more detailed level.

40-43. (Canceled)



Applicant : Qian Chen et al.  
Serial No.: 09/848,773  
Filed : May 3, 2001

Attorney's Docket No.: 06666-076001

44. (Currently Amended) A method, comprising:  
obtaining information about an image from two uncalibrated  
cameras;

using said information from said two uncalibrated cameras  
to obtain three-dimensional information;

wherein said using comprises rectifying said images is to  
form coplanar images with scan lines that are horizontally  
parallel; and

further comprising finding an average of said scan lines  
between one end of a first image and another end of a second  
image, and reforming said scan lines between said one end and  
another end to form said horizontally parallel scan lines;

~~further comprising using said information to form a  
disparity surface which represents three-dimensional information  
corresponding to each of said two dimensional points;~~

~~wherein said using comprises forming a three-dimensional  
surface indicative of three-dimensional information contained in  
said two images, and forming a variable which indicates a  
likelihood of error in said three dimensional surface; and~~

~~wherein said forming a disparity surface comprises forming  
a plurality of seed voxels, and tracing a surface of said  
plurality of seed voxels.~~

Applicant : Qian Chen et al.  
Serial No.: 09/848,773  
Filed : May 3, 2001

Attorney's Docket No.: 06666-076001

45. (Canceled)

46. (Currently Amended) A method, comprising:

obtaining information about an image from two uncalibrated cameras;

using said information from said two uncalibrated cameras to obtain three-dimensional information;

wherein said using comprises rectifying said images is to form coplanar images with scan lines that are horizontally parallel; and

further comprising using information from said rectified images to form third dimension information associated with each of said two-dimensional points of said image;

~~wherein said using comprises forming a three dimensional surface indicative of three dimensional information contained in said two images, and forming a variable which indicates a likelihood of error in said three dimensional surface and tracing a surface defined by a plurality of seed voxels which have a low likelihood of error.~~

Applicant : Qian Chen et al.  
Serial No.: 09/848,773  
Filed : May 3, 2001

Attorney's Docket No.: 06666-076001

47. (Original) A method as in claim 46, wherein said third dimensional information includes a probability that the third dimensional information is correct.

48. (Original) A method as in claim 46, further comprising dividing the image into a plurality of patches, and finding said third dimensional information for each of said plurality of patches.

49. (Original) A method as in claim 48, further comprising determining third dimensional information for pixels on edges of said patches.

50-54. (Canceled)

55. (Previously Presented) A method, comprising:  
obtaining two images of similar image content;  
forming a disparity map of three dimensional information for specified coordinates of matching pixels by forming a plurality of areas, finding seed voxels in each of said plurality of areas which have relatively high probability of being correct matches and propagating to other pixels from said seed voxels;

Applicant : Qian Chen et al.  
Serial No.: 09/848,773  
Filed : May 3, 2001

Attorney's Docket No.: 06666-076001

wherein said propagating comprises forming a surface in a volume as said disparity surface; and

wherein said surface is continuous in the space (x,y,d) where x and y are the coordinates of the pixel, and d is the amount of disparity of the pixel.

56. (Canceled)

57. (Original) A method as in claim 55, wherein said finding seed voxels comprises reviewing each said section, and finding a voxel with a peak correlation value in each said section as said seed voxel.

58. (Original) A method as in claim 55, wherein said finding seed voxels comprises reviewing each said section, and finding a first found voxel with a correlation value greater than a specified threshold in each said section as said seed voxel.

59. (Original) A method as in claim 55, further comprising calculating first information at a first resolution for said seed voxels, and calculating second information, at a second

Applicant : Qian Chen et al.  
Serial No.: 09/848,773  
Filed : May 3, 2001

Attorney's Docket No.: 06666-076001

resolution less than said first resolution, for other voxels  
other than said seed voxels.

60. (Original) A method, comprising:  
obtaining two images of similar image content;  
forming a disparity map of three dimensional information  
for specified coordinates of matching pixels by forming a  
plurality of areas, finding first information in each of said  
plurality of areas which have relatively high probability of  
being correct matches and obtaining said first information at a  
first resolution, and propagating along a surface to obtain  
second information at a second resolution less than said first  
resolution.

61. (Original) A method as in claim 60, wherein said two  
images are from two separate image sources.

62. (Original) A method as in claim 60, wherein said first  
information is seed information.

63. (Original) A method as in claim 60, wherein said seed  
information is obtained by a winner-take-all test, where, at

Applicant : Qian Chen et al.  
Serial No.: 09/848,773  
Filed : May 3, 2001

Attorney's Docket No.: 06666-076001

each pixel  $(u,v)$ , all voxels  $(u,v,d)$  where  $d \in [-W_0/2, W_0/2]$  are computed, and a voxel with a maximum correlation value is used.

64. (New) A method, comprising:

obtaining two images of similar image information from two uncalibrated sources;

superimposing lines formed on said images to rectify the two images relative to one another to form rectified images; and

using said rectified images to form three-dimensional information by forming a disparity map of three dimensional information for specified coordinates of matching pixels.

65. (New) A method as in claim 64, wherein said using comprises forming a disparity map indicating an estimate of the three dimensional surface, and information about likelihood of said estimate.

66. (New) A method as in claim 64, further comprising initially manually establishing matching parts, and wherein said using comprises automatically using said rectified images to form said three-dimensional information.

Applicant : Qian Chen et al.  
Serial No.: 09/848,773  
Filed : May 3, 2001

Attorney's Docket No.: 06666-076001

67. (New) A method as in claim 66 wherein said manually obtaining comprises identifying identifiable parts in the image.

68. (New) A method as in claim 64 wherein said superimposing comprises defining said images in terms of epipolar geometry, and aligning said images in said epipolar geometry.

69. (New) A method as in claim 65, wherein said rectification transformation in said epipolar geometry is one which aligns specified reference lines in the image.

70. (New) A method as in claim 69, wherein said reference lines include lines passing through manually-obtained image parts.

71. (New) A method as in claim 70, wherein said transformation aligns said specified reference lines by finding an average of end points of two different reference lines, and forming a line through an averaged part.

Applicant : Qian Chen et al.  
Serial No.: 09/848,773  
Filed : May 3, 2001

Attorney's Docket No.: 06666-076001

72. (New) A method as in claim 64, wherein said using comprises forming a disparity surface indicative of three-dimensional information of the image.

73. (New) A method as in claim 72, wherein said disparity surface includes information indicative of a difference between coordinates of matching pixels.

74. (New) A method as in claim 72, further comprising forming a variable denoting a degree of similarity between pixels.

75. (New) A method as in claim 64, wherein said using comprises forming a three-dimensional surface indicative of three-dimensional information contained in said two images, and forming a variable which indicates a likelihood of error in said three-dimensional surface.

76. (New) A method, comprising:  
obtaining information about an image from two uncalibrated cameras;

using said information from said two uncalibrated cameras to obtain three-dimensional information;



Applicant : Qian Chen et al.  
Serial No.: 09/848,773  
Filed : May 3, 2001

Attorney's Docket No.: 06666-076001

wherein said using comprises rectifying said images to form coplanar images with scan lines that are horizontally parallel; and

wherein said rectifying comprises identifying points in each of the images, and identifying scan lines which pass through said points.

77. (New) A method as in claim 44, further comprising using said information to form a disparity surface which represents three-dimensional information corresponding to each of said two-dimensional points.

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